

# Exploring biomedical waste management and disposal practices among hospitals in Port Harcourt, Rivers State

*Exploración de las prácticas de gestión y eliminación de residuos biomédicos en los hospitales de Port Harcourt, Estado de Rivers*

David Chinaecherem Innocent<sup>1</sup> , Cosmas Nnadozie Ezejindu<sup>2</sup>, Stanley Chinedu Eneh<sup>3</sup> , Angelica Chinecherem Uwaezuoke<sup>4</sup> , Valentine Nnachetam Unegbu<sup>5</sup>, Advait Vasavada<sup>6</sup> 

1. Department of Public Health, Federal University of Technology Owerri, Imo State Nigeria

2. Department of Public Health, Abia State University, Uturu, Abia State, Nigeria

3. Department of Community Health, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

4. Department of Medicine and Surgery, University of Nigeria, Nsukka, Enugu State, Nigeria

5. Department of Biological Sciences, Spiritan University Nneochi, Abia State, Nigeria

6. MP Shah Medical College, Jamnagar, India

## Corresponding author

David Chinaecherem Innocent  
E-mail: innocentdc1@gmail.com

Received: 4 - I - 2023

Accepted: 3 - II - 2023

doi: 10.3306/AJHS.2023.38.03.79

## Abstract

**Background:** Globally, disposal of biomedical waste is an environmental concern, as most medical wastes are infectious and could potentially lead to the spread of infectious diseases. The aim of this study was to assess the biomedical waste management and disposal practices among hospitals in Port Harcourt, Rivers state.

**Method:** A hospital based cross sectional design was adopted for this study on the biomedical waste management and disposal practices among hospitals in Port Harcourt, Rivers state. Statistical package for Social Sciences (SPSS) version 22.0 was used for the analysis of the study and chi square to determine association between variables ( $P=0.05$ ). A structured questionnaire was used for data collection and a stratified and simple random sampling technique was used to draw out a total of 202 respondents who participated for the study.

**Results:** The study revealed that 35% (70) of the respondents were between 35-44 years of age. Overall knowledge of biomedical waste management among the health workers was 80.2%. From the study, Age ( $p=0.00923$ ), Level of Education ( $p=0.0025$ ) and Length of experience ( $p=0.0457$ ) were all associated with the level of knowledge of biomedical waste management.

**Conclusion:** A significant number of hospital workers are aware of biomedical waste generation, management and disposal practices. Although, attitude to biomedical waste management and disposal practices among health workers is average therefore a challenge. Sensitization of hospital staff by the public health personnel to improve biological waste disposal among the inexperienced is recommended. Also the government and policy makers should design laws that would facilitate the reduction and susceptibility of improper hospital waste disposal.

**Key words:** Waste Management, Biomedical waste, Knowledge, Attitude, Waste Disposal, Hospitals.

## Resumen

**Antecedentes:** En todo el mundo, la eliminación de los desechos biomédicos es una preocupación ambiental, ya que la mayoría de los desechos médicos son infecciosos y podrían conducir a la propagación de enfermedades infecciosas. El objetivo de este estudio era evaluar las prácticas de gestión y eliminación de residuos biomédicos en los hospitales de Port Harcourt, estado de Rivers.

**Método:** Se realizó un diseño transversal sobre las prácticas de gestión y eliminación de residuos biomédicos en los hospitales de Port Harcourt, estado de Rivers. Se utilizó el paquete estadístico para las ciencias sociales (SPSS) versión 22.0 para el análisis del estudio y el chi cuadrado para determinar la asociación entre las variables ( $P=0.05$ ). Se utilizó un cuestionario estructurado para la recogida de datos y una técnica de muestreo aleatorio estratificado y simple para extraer un total de 202 encuestados que participaron en el estudio.

**Resultados:** El estudio reveló que el 35% (70) de los encuestados tenía entre 35 y 44 años de edad. El conocimiento general de la gestión de residuos biomédicos entre los trabajadores sanitarios era del 80,2%. Del estudio se desprende que la edad ( $p=0,00923$ ), el nivel de estudios ( $p=0,0025$ ) y la antigüedad ( $p=0,0457$ ) están asociados al nivel de conocimientos sobre la gestión de residuos biomédicos.

**Conclusiones:** Un número significativo de trabajadores hospitalarios conoce las prácticas de generación, gestión y eliminación de residuos biomédicos. Sin embargo, la actitud hacia las prácticas de gestión y eliminación de residuos biomédicos entre los trabajadores sanitarios es media, por lo que constituye un reto. Se recomienda la sensibilización del personal hospitalario por parte del personal de salud pública para mejorar la eliminación de residuos biológicos entre los inexpertos. Asimismo, el gobierno y los responsables políticos deberían diseñar leyes que faciliten la reducción y la susceptibilidad de la eliminación inadecuada de residuos hospitalarios.

**Palabras clave:** Gestión de residuos, residuos biomédicos, conocimientos, actitud, eliminación de residuos, hospitales.

## Introduction

Biomedical waste or hospital waste is any kind of waste containing infectious (or potentially infectious) materials<sup>1</sup>. It may also include waste associated with the generation of biomedical waste that visually appears to be of laboratory or medical origin (example unused bandages, packaging, infusion kits), also research laboratory waste containing organisms or biomolecules that are mainly restricted from environmental release<sup>1</sup>. Biomedical waste is a type of biowaste and they may also be called medical or clinical waste. Biomedical waste is spawned from medical and biological sources and activities such as the diagnosis, prevention or treatment of diseases. Common producers of biomedical waste include hospitals, health clinics, nursing homes, and medical research laboratories, dentists, and emergency medical services, offices of physicians, veterinarians, morgues or funeral homes. Biomedical waste can be solid or liquid<sup>2</sup>.

Biomedical waste management involves activities from generation of waste to final disposal. It includes those measures taken in the generation, characterization, quantification, storage, handling, collection, transportation, and disposal of wastes<sup>1</sup>. Biomedical waste is separate from normal trash or general waste and differs from other type of hazardous waste such as chemical, industrial and radioactive waste. It has become a major public health concern globally due to the potential of poorly managed hospital waste to cause disease and injury. The sustainable management of hospital waste has continued to generate increasing public health interest due to the health problems associated with exposure of human beings to potentially hazardous wastes arising from healthcare<sup>3</sup>.

In Nigeria, hospital waste is divided into two different groups which include infectious and non-infectious wastes. Infectious wastes include unwanted microbiological cultures and stock of infectious agents, pathological waste, waste from surgery or autopsy that were in contact with infectious agents, sharps (which includes potentially contaminated used and unused discarded needles, syringes, scalpels, lancets and other devices that can penetrate the skin), waste from human blood and products of blood, laboratory waste and other medical supplies that may have come in contact with blood or body fluids<sup>4</sup>. The non-infectious wastes includes general hospital wastes generated in the course of administrative and housekeeping functions of hospital establishments; and hence are comparable to the usual domestic waste.

Presently, considerable gap exist with regard to the assessment of hospital waste disposal practices in line with the hospital waste management and disposal plan particularly in Nigeria and in other countries in Sub-Saharan Africa. The need to absorb the processes prescribed in the hospital waste management and disposal plan becomes a necessity in view of the promiscuous dumping of hospital

waste in the metropolitan city of Port Harcourt, Rivers State, Nigeria. The nature and quantity of hospital waste generated as well as institutional practices with regards to sustainable methods of hospital waste management and disposal, including waste segregation and waste recycling are often poorly examined and documented. This is seen in several countries of the world including Nigeria, despite the health risks posed by the improper handling of hospital waste<sup>5</sup>. However, about 10-25% of hospital wastes is hazardous, and can create variety of health risks if not properly managed and disposed.

WHO estimates that over 20 million infections of hepatitis B, hepatitis C and HIV occur yearly due to unsafe sharp disposal following the re-use of syringes and needles without sterilization<sup>6</sup>, while the indiscriminate dumping of other hospital wastes can lead to ground and surface water contamination, and even cancer<sup>7</sup>. Other health problems associated with improper collection, treatment and disposal of hospital wastes include cholera, skin diseases, typhoid fever, malaria and gastroenteritis<sup>8</sup>. Indiscriminate burning and incineration of hospital waste have been linked to serious public health threat and pollution resulting in the release of toxic dioxin, mercury and many other toxic substances. These substances produce remarkable variety of adverse effects in humans even at extremely low doses<sup>9</sup>. Putrefaction occurs in portions of open refuse dumps, which have not been fully burnt and add to air pollution through foul smells and release of greenhouse gases. Sanitary landfill of hospital waste can lead to pollution of ground water if not properly managed. These make the safe waste disposal of biomedical wastes a necessity, a fact that has been emphasized in various international conventions including Agenda 21, adopted in 1992 at United Nations Conference on the Environment and Development (UNCED) which recommends the prevention and minimization of waste production, the reuse or recycling of waste to the extent possible, and the treatment of waste by safe and environmentally sound methods<sup>10</sup>. It is also of serious concern that the level of awareness and practice, particularly of health workers regarding biomedical or hospital waste management and disposal plan has not been adequately documented. WHO Program activities include developing technical guidance materials for assessing the quantities and types of waste produced in different facilities, creating national action plans, developing national healthcare waste management and disposal guidelines and building capacity at national level to enhance the way biomedical waste is dealt with in low-income countries<sup>11</sup>. Classification of hospital wastes shows that of the total amount of waste generated by hospital activities, about 80% is general waste. The remaining 20% is considered hazardous material that may be infectious, toxic or radioactive. Every year an estimated 16,000 million injections are administered worldwide<sup>6</sup>, but not all of the needles and syringes are properly disposed of afterwards.

Biomedical waste contains potentially harmful microorganisms which can infect hospital patients, hospital workers and the general public. Hospital activities protect and restore health and save lives and reverse should not be the case in the various hospitals across the country. Disposal of biomedical waste is an environmental concern, as most medical wastes are infectious and could potentially lead to the spread of infectious diseases. Daily exposure to biomedical wastes leads to accumulation of harmful microorganisms in the body of exposed persons<sup>8</sup>. Improper disposal of hospital waste can have both direct and indirect health consequences on humans and the environment. Indirect consequences in form of toxic emissions from inadequate burning of biomedical waste<sup>12</sup>. In developing countries like Nigeria, where many hospitals are competing for limited resources, the management and disposal of hospital wastes has received less attention and the precedence it deserves. Some hospitals dispose their biomedical wastes to municipal dumpsites without pre-treatment, leading to an unhealthy and hazardous environment. When dumped into the sea, it discharges poisons into the waters and it would be consumed by the marine creatures, the toxins would inject into the food chain and finally reach humans who consume the sea foods. Human exposure to such toxins can stunt human growth development and also cause birth defects. This trend is currently being experienced in Port Harcourt, Nigeria even when every disposal site is required by law to have environmental pollution prevention and control measures. Hundreds of tons of biomedical wastes are deposited in open dumpsites at the hospitals and on the roadsides of Port Harcourt metropolis, untreated and nonhazardous solid wastes, which now pose health risks to health workers, cleaning staff, patients, visitors, waste collectors, disposal site staff, waste pickers, drug addicts that use the contaminated syringes and needles. The overall objective of this study was to assess the biomedical waste management and disposal practices among hospitals in Port Harcourt, Rivers state.

## Methods

### Study Design and Setting

A hospital based cross sectional survey research design was adopted for the study to assess the biomedical waste management and disposal practices among hospitals in Portharcourt, Rivers State Nigeria, from May, 2021 to October, 2021.

The study was carried out within the capital of Rivers state known as Portharcourt city. Portharcourt is located in the southern Nigeria (Niger Delta).

### Study Population

The study population includes health workers of the hospitals in the group of doctors, nurses, pharmacists, staff of laboratory departments and waste handlers. The study population also included the public and private hospitals.

The hospitals in Port Harcourt is 253 in number and it comprises of one (1) Federal Government owned, one (1) State Government owned and 251 individually owned hospitals.

### Sample Size and Sampling Methods

Sample size for comparison of two proportions was used to determine minimum number of staff to be interviewed from each hospital and a total sample size of 218 was obtained.

A stratified and simple random sampling technique was used to draw out the number of respondents from each hospital using a table of random numbers for the study. The health workers were stratified according to their professional groups: doctors, nurses, pharmacists and laboratory staff, which amounted to four categories of health workers and the waste handlers. Then selection of respondents was done using simple random sampling via a computer generated table of random numbers. There was a list of staff in each stratum in all of the selected hospitals. Then serial numbers was assigned to each staff in keeping with the order of the list. Using the computer generated table of random numbers, participants was selected daily from each stratum in proportion to sample size until the total sample size was reached for both public and private hospitals.

Note: The selected hospitals in Portharcourt for the study included: University of Portharcourt Teaching Hospital (Owned and managed by the Federal Government of Nigeria), Braithwaite Memorial Specialist Hospital (BMH) Portharcourt (Owned and managed by the Rivers State Government), Queens Clinic and Pamo Clinic Portharcourt (owned by Individuals and managed privately).

### Instruments for Data Collection

A well-structured questionnaire for information gathering was used in this study. the questionnaire contained information on the socio-demographic characteristics of the respondents, information about the respondents knowledge on biomedical waste management and information on the attitude of the respondents towards biomedical waste management and disposal practices.

### Validity and Reliability

The questionnaire for this study was subjected to face validity. The questionnaire was designed in a simple language to avoid ambiguity, misinterpretation or misunderstanding of the questions or statements.

The test-retest method was used to test the reliability of the questionnaire using 10% of the sample size. This exercise was necessary because it enhanced the collection of relevant data, which also reduced bias. The analyzed data was reliable and the significant association set at  $p < 0.001$  with Fisher's Exact Test. A Cronbach coefficient of 0.88 was obtained for the study.

## Method of Data Collection

The questionnaire was administered to the health workers of the hospitals in the category of doctors, nurses, pharmacists and staff of laboratory departments, and waste handlers. Field observation of biomedical waste generation rate and quantification in both public and private hospitals was also carried out. The data collection tool was adapted from the rapid assessment tool developed for sub-Saharan African countries by the World Health Organization and the secretariat of the Basel Convention of the United Nations Environmental Program (UNEP). This tool was a biomedical waste management inventory questionnaire that was used in assessment of biomedical waste disposal practices in hospital.

## Method of Data Analysis

Data collected in this study were edited, coded and entered into the Statistical Product and Service Solutions (SPSS) version 22.0 and Microsoft Excel 2010. Table of frequencies and percentages were constructed. Chi-squared test and p-value less than 0.001 was used to show that there is a significant association between the hospital workers and the assessment of biomedical waste disposal practice in the selected hospitals.

## Ethics

An approval was obtained from the research ethical committee of Public Health Department, School of Health Technology, Federal University of Technology Owerri alongside a letter of introduction issued from the administrative office before carrying out this research. The questionnaire was completed privately and anonymously (none of the respondents was identified by name at any point during data collection). Verbal informed consent was obtained from all the participants before being allowed to participate in this study.

## Results

### Socio demographic Factors of the respondents

From the **table I**, 35% (70) of the respondents were between 35-44 years of age, 23% (46) had respondents between 15-24 years, 19% (60) were aged 25-34 and just 13% (27) included respondents between ages 45-50. Majority of the respondents were of Igbo origin (58%), 17% (34) were Yoruba, 15% (13), Hausa, 5% (10) Fulani and 6% (11) of the respondents chose options not listed but label 'Others'. Considering education level, 44% (89) had attained the tertiary level of education, 38% (77) secondary, 13% (25) primary level of education and under 6% (10) had Informal education levels. When asked about their length of experience, 29% (58) replied "1-5 years", 28% (57) 6-10 years, 22% (45) said "11-15 years", 19% (38) had experience of 16-20 years and only 2% (4) had an experience of 21 years and above. Majority (71%) of the respondents accepted they were hospital staff, while 29% (59) replied "No". 61.5% (988) (n=143) affirmed they were public staff, while about 38.4% (55) chose 'Private'.

Contractors accounted for 74.1% (106) of the hospital staff while 25.8% (37) replied "No". On the positions of the respondents, 27% were Laboratory technicians, 28% (40) were Nurses, 26% (37) Pharmacists, and 11% (15) were Medical Doctors. (n=143). 8% (12) of the respondents were waste handlers.

### Respondents Knowledge on Biomedical Waste Management and Disposal Practices

Revealed in **table II** is the knowledge of respondents on biomedical waste management and disposal practices. 83% (168) of the respondents accepted it was important to know about biomedical medical waste generation, its hazards and safe management, while 17% (34) did not accept. When they were asked if they thought it was good to put all types of hospital waste into one container, 55% (110) replied "No", 41% (82) said "Yes", 5% (10) replied "Maybe". On question concerning knowledge of color-coding segregation of biomedical wastes, 61% (124) replied "Yes", 33% (68) said "No", and about 5% (10) replied "Maybe". 77% (155) of the respondents demonstrated that they followed color-coding for biomedical waste, while 23% (47) denied. 65% (122) of the respondents also took precautionary measures in handling hospital wastes according to the colors of their containers, while 35% (70) did not. Additionally, 65% (131) believed Personal protective equipment (PPES) can be useful in handling hospital waste, while 35% (71) denied. 32% (65), (n=202), used PPEs such as Cover-alls, 22% (45) used Safety boots, 17% (33) used personal protective gear not listed but label 'Others', 15% (31) used Hand gloves while 14% (28) used safety goggles. 49% (65) (n=131) of the respondents always wore PPEs, 29% (38) rarely, and 22% (28) only wore PPEs occasionally. When asked concerning disposing needles in general waste containers, 67% (135), replied "No", while 33% (67) said "Yes". 46% (94), reported they re-capped the used needles before disposal, 44% (89) said "Not always", and 10% (19) replied "No". 61% (124) also discarded the used needles immediately, while 39% (78) did not. Concerning needle stick injuries, 83% (167) obliged it was a problem, while 17% (35) did not accept. 24% (49) reported to be victims of Needle stick injuries while 76% (153) had not experienced such accidents. Majority (72%), (n=49), of the Needle stick injury victims had experienced it about 1-5 times and 74% (36) of them filed a report. 62% (126) of the respondents demonstrated awareness of the consequences of needle-stick injuries, while 38% (78) denied. On disposal of hospital wastes in open places, 86% (174) denied, while a small 14% (28) accepted, the former said to have buried them (30%), Incinerate the waste (27%), Burn them (6%), land fill them (7%) and 29% (51) of the respondents opted for disposal methods not listed but label 'Others'. 65% (131) of the respondents demonstrated use of covered trucks for hospital waste disposal, while 35% (71) used open trucks. Majority of the respondents (92%, 185), also dumped hospital wastes in Municipal dumpsites, while under 8% (17) reported 'Rivers'. From **figure 1**, the respondent's good knowledge of biomedical waste was 80.2% and poor knowledge was 19.2%

**Table I:** Socio demographic Factors of the respondents.

Characteristics	Frequency (n=202)	Percentage (%)
<b>Age</b>		
15-24	46	23%
25-34	60	19%
35-44	70	35%
45-50	27	13%
<b>Total</b>	202	100
<b>Ethnicity</b>		
Igbo	118	58%
Hausa	13	15%
Yoruba	34	17%
Fulani	10	5%
Others	11	6%
<b>Total</b>	202	100
<b>Educational level</b>		
Informal education	10	5%
Primary	25	13%
Secondary	77	38%
Tertiary	89	44%
<b>Total</b>	202	100
<b>Length of experience in years</b>		
1-5 years	58	29%
6-10 years	57	28%
11-15 years	45	22%
16-20 years	38	19%
21 years and Above	4	2%
<b>Total</b>	202	100
<b>Are you a Hospital Staff</b>		
Yes	143	71%
No	59	29%
<b>Total</b>	202	100
<b>Hospital category</b>		
Public	88	61.5%
Private	55	38.4%
<b>Total</b>	143	100
<b>Are you a contractor?</b>		
Yes	106	74.1%
No	37	25.8%
<b>Total</b>	143	100
<b>What is your position?</b>		
Doctor	15	11%
Nurse	40	28%
Pharmacist	37	26%
Laboratory Technician	39	27%
Waste Handlers	12	8%
<b>Total</b>	143	100

### Respondents Attitude on Biomedical Waste Management and Disposal Practices

Illustrated in **table III**, 83% (168) replied "Yes" when asked if biomedical wastes are hazardous, while 17% (34) replied "No". The respondents (n = 168) reported they handles such wastes carefully, 28% (48) replied "Like common waste", 32% (53) did not specify but opted to choose 'Others'. 52% (104) scored safe management of biomedical waste as Good, 35% (71) Poor, and 13% (27) Fair. When the respondents were asked if proper management of biomedical waste can be seen as a financial burden on the hospital management, 64% (129) replied "Yes" and 36% did not oblige. 26% (52) of the respondents confirmed proper management of biomedical waste be achieved in the hospital through Team work, 25% (50) opined "Public Health Awareness", 18% (38) chose individual efforts, 11% (22) accepted all options were necessary and 19% (39) rejected all

available options. 76% (150) of the respondents reported that safe management of biomedical waste disposal was an extra burden on the workers duties, and 58% (117) obliged containers should be labeled before filling with waste. Also 65% (130) of the respondents agreed that infectious waste should be sterilized from infections before disposal. The respondents were asked if they would voluntarily attend program that will enhance and upgrade their knowledge about biomedical waste, 87% (175) agreed, while 13% (27) did not accept.

### Association between Socio demographic characteristics and Level of Knowledge of biomedical waste among health workers

Revealed in **table IV** are the results for the test of a statistically significant relationship between Socio-demographic characteristics and Level of knowledge of biomedical waste among health workers. There was a statistically significant relationship between Age and Level of knowledge of biomedical waste among health workers in the study population,  $\chi^2 = 1.342$ ,  $df=3$ ,  $p= 0.00923$ . We therefore reject the null hypothesis of no significant relationship between Age and Level of knowledge of biomedical waste among health workers in the study population. Considering the hypothesis between Level of Education of health workers and knowledge of biomedical waste among health workers among relevant population, there was a statistically significant relationship between them,  $\chi^2 = 1.2348$ ,  $df=3$ ,  $p= 0.0025$ , therefore we reject the null hypothesis of no significant relationship between Level of Education of health workers and knowledge of biomedical waste among health workers in the study population. Given the relationship between Length of experience in years and knowledge of biomedical waste in the study population, there was a statistically significant association;  $\chi^2 = 3.432$ ,  $df=3$ ,  $p= 0.0457$ , therefore we reject the null hypothesis of no significant association between Length of experience in years and knowledge of biomedical waste in the study population. On the hypothesis between Being a Hospital Staff and knowledge of biomedical waste among primal population, There was a statistically significant relationship between Being a Hospital Staff and knowledge of biomedical waste in the study population,  $\chi^2 = 2.653$ ,  $df=1$ ,  $p= 0.00789$ . We therefore reject the null hypothesis of no significant relationship between Being a Hospital Staff and knowledge of biomedical waste in the study population. There was no statistically significant relationship considering the hypothesis between being a contracted worker and knowledge of biomedical waste among relevant population.  $\chi^2 = 5.235$ ,  $df=1$ ,  $p= 0.01934$ , therefore we fail to reject the null hypothesis of no significant relationship between being a contracted worker and knowledge of biomedical wastes. Considering the association between position in the hospital and knowledge of biomedical wastes, there was a statistically significant relationship.  $\chi^2 = 1.324$ ,  $df=1$ ,  $p= 0.00765$ , Therefore we reject the null hypothesis of no significant association between position in the hospital and knowledge of biomedical wastes among relevant population.

**Table II:** Respondents Knowledge on Biomedical Waste Management and Disposal Practices.

Variables	Frequency (n=202)	Percentage (%)
<b>Do you think it is important to know about biomedical medical waste generation, its hazards and safe management?</b>		
Yes	168	83%
No	34	17%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you think it is good to put all types of hospital waste into one container?</b>		
Yes	82	41%
No	110	55%
Maybe	10	5%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you know about colour-coding segregation of biomedical wastes?</b>		
Yes	124	61%
No	68	33%
Maybe	10	5%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you follow colour-coding for biomedical waste?</b>		
Yes	155	77%
No	47	23%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you take precaution in handling hospital wastes according to the colours of their containers?</b>		
Yes	132	65%
No	70	35%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you believe that personal protective equipments ( PPEs ) like gloves can beuseful in handling hospital wastes?</b>		
Yes	131	65%
No	71	35%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you wear Personal Protective Equipments?</b>		
Hand Gloves	31	15%
Cover-alls	65	32%
Safety booth	45	22%
Safety goggle	28	14%
Others	33	17%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>If Yes, how often do you wear PPEs?</b>		
Rarely	38	29%
Always	65	49%
Occasionally	28	22%
<b>Total</b>	<b>131</b>	<b>100</b>
<b>Are needles supposed to be put into general waste containers?</b>		
Yes	67	33%
No	135	67%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you re-cap the used needle?</b>		
Yes	94	46%
No	19	10%
Not always	89	44%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you discard the needle Immediately?</b>		
Yes	124	61%
No	78	39%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Is needle-stick injury a concern?</b>		
Yes	167	83%
No	35	17%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Have you had needle stick injury in the past one year?</b>		
Yes	49	24%
No	153	76%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>If Yes, how many times?</b>		
1-5	39	72%
6-10	9	17%
Above 10	6	11%
<b>Total</b>	<b>49</b>	<b>100</b>
<b>Did you fill an incident report?</b>		
Yes	36	74%
No	13	26%
<b>Total</b>	<b>49</b>	<b>100</b>
<b>Are you aware of the consequences of needle-stick injury?</b>		
Yes	126	62%
No	76	38%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Do you dispose hospital waste in open Places?</b>		
Yes	28	14%
No	174	86%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>If No, What do you do with them?</b>		
Burn Them	11	6%
Bury Them	52	30%
Incinerate Them	47	27%
Land fill Them	13	7%
Others	51	29%
<b>Total</b>	<b>174</b>	<b>100</b>
<b>What kind of trucks do you use in disposal of hospital wastes?</b>		
Covered Trucks	131	65%
Open Trucks	71	35%
<b>Total</b>	<b>202</b>	<b>100</b>
<b>Where do you dump the hospital wastes?</b>		
Municipal dumpsites	185	92%
Rivers	17	8%
<b>Total</b>	<b>202</b>	<b>100</b>

**Table III:** Respondents Attitude on Biomedical Waste Management and Disposal Practices.

Variable		Frequency (n=202)	Percentage (%)
Is biomedical waste a hazardous waste?	Yes	168	83%
	No	34	17%
	<b>Total</b>	<b>202</b>	<b>100</b>
If Yes, how do you handle such waste?	Carefully	67	40%
	Like common waste	48	28%
	Others specify	53	32%
	<b>Total</b>	<b>168</b>	<b>100</b>
How can you score safe management of biomedical waste? Poor	Good	104	52%
	71	35%	
	Fair	27	13%
	<b>Total</b>	<b>202</b>	<b>100</b>
Can proper management of biomedical waste be seen as a financial burden on the hospital management?	Yes	129	64%
	No	73	36%
	<b>Total</b>	<b>202</b>	<b>100</b>
How can proper management of biomedical waste be achieved in the hospital?	Individual Effort	38	19%
	Team Work	52	26%
	Public Health Awareness	50	25%
	All of the Above	22	11%
	None of the Above	39	19%
	<b>Total</b>	<b>202</b>	<b>100</b>
Is safe management of biomedical waste an extra burden on the workers duties?	Yes	150	76%
	No	52	24%
	<b>Total</b>	<b>202</b>	<b>100</b>
Do you think that labeling the container before filling it with waste is of any clinical concern?	Yes	117	58%
	No	85	42%
	<b>Total</b>	<b>202</b>	<b>100</b>
Do you think that infectious waste should be sterilized from infections before its disposal?	Yes	130	65%
	No	72	35%
	<b>Total</b>	<b>202</b>	<b>100</b>
Will you like to attend voluntarily programmes that will enhance and upgrade your knowledge about biomedical waste?	Yes	175	87%
	No	27	13%
	<b>Total</b>	<b>202</b>	<b>100</b>

**Table IV:** Association between Socio demographic characteristics and Level of Knowledge of biomedical waste among health workers.

Socio Demographics	Knowledge of Biomedical Wastes		X <sup>2</sup>	P-value	Decision
	High (%)	Low (%)			
<b>Age</b> 15-24 25-34 35-44 45-50	16(40.0)	34(60.0)	1.342	0.00923	<b>Sig.</b>
	36 (60.0)	24(40.0)			
	40(57.1)	30(42.9)			
	25(92.5)	2(7.4)			
<b>Educational level</b> Informal education Primary Secondary Tertiary	3(30.0)	7(70.0)	1.2348	0.0025	<b>Sig.</b>
	14(56.0)	11(44.0)			
	47(61.0)	30(39.0)			
	59(66.2)	30(33.8)			
<b>Length of experience in years</b> 1-5 years 6-10 years 11-15 years 16-20 years 21 years and Above	27(46.5)	31(53.4)	3.432	0.0457	<b>Sig.</b>
	37(64.9)	20(35.1)			
	33(73.3)	12(26.7)			
	36(94.7)	2(52.6)			
	4(100)	0(0)			
<b>Are you a Hospital Staff</b> Yes No	73(51.0)	70(48.9)	2.653	0.00789	<b>Sig.</b>
	39(66.1)	20(33.8)			
<b>Are you a contractor?</b> Yes No	80(75.4)	26(24.5)	5.235	0.1934	<b>Insig.</b>
	30(81.0)	7(18.9)			
<b>What is your position?</b> Doctor Nurse Pharmacist Laboratory Technician Waste Handlers	10(66.6)	5(33.3)	1.324	0.00765	<b>Sig.</b>
	29(72.5)	11(27.5)			
	30(81.0)	7(18.9)			
	20(51.2)	19(48.7)			
	8(66.6)	4(33.3)			

## Discussion

The objective of this study was to evaluate biomedical waste management and disposal practices in hospitals in Port Harcourt, Rivers State, Nigeria. Considering the socio-demographic characteristics, with regards to age, findings from the study showed that 35% of the respondents were within the age group 35-44 years, the age seen in this study, is in consistence with the statement by John *et al.*,<sup>14</sup> that 34.5% of hospital workers fall within this age category. Further findings from this study showed that 58% of the respondents were of Igbo origin and Christians. This could be because the study was conducted in the Southern part of Nigeria and the hospitals surveyed were located in Port Harcourt, Rivers State which is a neighboring eastern state of the federation predominated by Igbo people. This is also in consistence with the study conducted by Brisbe and Ordinoha,<sup>10</sup> this study revealed that majority of the respondents (71%) are hospital staff and 74.1% are contractors. This signifies that majority of the hospital staff is not permanent staff and probably have other clinics or hospitals they earn a living out of and hence attention to work might be divided. This connotes a consistence with a similar study conducted by Cheeseman & Townend<sup>12</sup> and in contrast with a statement made in a publication by Griault<sup>15</sup>.

The findings of the study considering the knowledge of the forms of biomedical waste management and disposal practices revealed that 83% of the respondents accepted it was important to know about biomedical medical waste generation, its hazards and safe management. This implies that health workers have significant knowledge of the importance of controlled generation and disposal of biomedical wastes. This corroborates a publication by Da Silva *et al.*,<sup>3</sup> that 85.2% of health workers in hospitals have an awareness of biomedical disposal practices. Concerning knowledge of color-coding segregation of biomedical wastes, 61% affirmed. This could be due to the fact that color-coding segregation of waste is a standard practice and has been adopted by most health facilities. A study by Kevin & Oguamanam<sup>16</sup> is in consistence with this finding. Further investigation into the finding of this study shows that majority (77%) of the respondents demonstrated that they followed color-coding for biomedical waste, as corroborated by a previous finding by Ferreira<sup>2</sup> that medical facilities are required to ensure biomedical wastes are color-coded for disposal. Several studies also support this finding<sup>17,3,18,19,2,15,20</sup>. This study revealed that 35% of the respondents did not take precautionary measures in handling hospital wastes according to the colors of their containers. This could be due to lack of provision of relevant colors of containers for biomedical waste disposal by the health facilities. This goes in contrast to a statement made in a publication by Adogu, & Ubajaka<sup>21</sup> that under 10% of hospital workers in a survey did not take precautions in handling hospital wastes according

to the colors of their containers. Some studies by Buregyega *et al.*,<sup>22</sup> Caviar *et al.*,<sup>9</sup> Chauhan *et al.*,<sup>7</sup> disagree with this finding. Additionally, 65% of hospital workers believed Personal protective equipment (PPES) can be useful in handling hospital waste, and the most adopted PPES are the cover-alls (35%). This could be because the cover-all ensures limbs and trunk are fully protected from biomedical wastes. This is in consistence to a similar study conducted by Abitebul and Loft<sup>23</sup> on the adoption of cover-all by hospital workers (39%). 83% of the respondents obliged Needle stick injuries are common, while 76% had not experienced such accidents. This finding falls in line with a previous study by<sup>12</sup> that 81% of hospital workers demonstrated knowledge of needle stick injuries and that 74% in a survey conducted did not experience needle stick injuries. This is in contrast to a publication by<sup>22</sup>. On disposal of hospital wastes in open places, 86% denied. This implies stringent adherence to laws put in place to check the disposal of biomedical wastes. Numerous publications support this finding<sup>24,25,23,26</sup>. 65% of the respondents illustrated use of covered trucks for hospital waste disposal which is in line with required standard procedure, also Majority of the respondents (92%) also dumped hospital wastes in Municipal dumpsites, advance findings from this study show that under 8% reported 'Rivers'. This could be due to nonavailability of designated dumpsites in proximity or no dumpsites at all provided by relevant bodies.

Considering the information attitude on biomedical waste management and disposal Practices among respondents, the study revealed that based on overall response from the participants that 83% affirmed biomedical wastes are hazardous. This falls in line with previous studies<sup>27,17,3</sup>. 52% of the respondents scored safe management of biomedical waste as 'Good', while 64% think that proper management of biomedical waste can be seen as a financial burden on the hospital management. This could mean the hospitals lack adequate resources for proper management of biomedical wastes and is corroborated by a publication by Alagoz & Kocasoy<sup>28</sup>. 76% of the respondents reported that safe management of biomedical waste disposal was an extra burden on the workers duties. The implication here could be that most hospitals are understaffed and hence workers have to engage in more tasks than they should perform. A previous study by Adetunji *et al.*,<sup>29</sup> explicitly explained the problems of under-staffing. Also 65% of the respondents agreed that infectious waste should be sterilized from infections before disposal. 87% of the respondents accepted to voluntarily attend programs that will enhance and upgrade their knowledge about biomedical waste, further check into this study revealed that 13% did not accept. This could be due to lack of motivation and poor attitude to work created as a result of untimely and underpaid monthly earnings. This is in consistence to several studies<sup>14,16,30,31</sup>.



Findings from this study regarding the association between Socio demographic Characteristics and Level of knowledge of biomedical wastes revealed that Age is significantly associated with level of knowledge of biomedical wastes among health workers ( $P=0.00923$ ). This implies that there was a significant increase in the level of knowledge of biomedical wastes as the age of the respondents under consideration increased. This could be due to the exposure that come with increased age, which could imply increase length in practice and is in line with studies by Da Silva *et al*,<sup>3</sup> which found age to be associated with knowledge of biomedical wastes ( $P=0.00861$ ). Moving further, the study also demonstrated that the level of education of health workers is significantly associated with the knowledge of biomedical waste ( $P=0.0025$ ). This could be due to the fact that the higher the education level of the respondents the more likely they must have come across biomedical waste management and disposal practices. This goes in contrast with a report published by Abitebul & Loft,<sup>23</sup> that the education level of health workers may not affect the level of knowledge of biomedical wastes among primal population. Also, from the study among health workers in selected hospitals in Portharcourt, Rivers State, it was posited that length of experience in years shows significant association with level of knowledge of biomedical wastes ( $P=0.0457$ ). Study shows that the level of knowledge of biomedical wastes was minimal among respondents who have practiced for 1-5 years, compared to health workers with 21 years and above practice experience. This is in consistence to studies conducted by Buregyega *et al*,<sup>22</sup> Caviar *et al*,<sup>9</sup> and Chauhan *et al*,<sup>7</sup> but goes against a publication by Grioult<sup>15</sup>. The study revealed that level of knowledge of biomedical wastes was high among the waste handlers 66.6% compared to any other position among health workers in the Portharcourt hospitals and hence a significant relationship ( $P=0.00765$ ). Studies according to Cheeseman & Townend<sup>12</sup> stated that health workers who are responsible for waste handling in hospitals had the highest knowledge of biomedical wastes and disposal practices. This level of knowledge could be due to the position of employment in these hospitals respectively.

## Conclusion

Based on the outcomes of the study, it could be seen that a significant number of hospital workers are aware of biomedical waste generation, management and disposal practices. This includes the use of PPES and color-coding hospital wastes before disposal. However, the attitude to biomedical waste management and disposal practices is average and therefore a challenge. The study also reveals that medical facilities lack adequate resources needed to properly dispose of biomedical wastes. Strict laws to guide disposal of hospital waste which have been put in place need to be reinforced. Also Ease of biomedical wastes disposal by creating dumpsites at strategic points should be considered. Hospital staff/workers should also be sensitized, encouraged on the hazards of biomedical wastes and Importance of good waste management. Understaffed hospitals are required to hire workers with relevant qualifications to promote biomedical waste management and disposal.

## Recommendations

Based on the finding of this study, it is recommended government and policy makers should design laws that would facilitate the reduction and susceptibility of improper hospital waste disposal. Also Provision of disposal facilities such as landfills sites and incinerators at strategic points to increase ease in disposition of biomedical wastes is imperative.

## Ethics Approval and consent to Participate

Not Applicable

## Consent to Publish

Not applicable

## Availability of Data and Materials

The Data set from the study are available to the corresponding author upon request.

## Competing Interests

Authors have declared that they have no competing interests

## Funding

No funds were received for this study

## Acknowledgements

Not Applicable

## References

- Jenkin LE, Noonan CL, Tudor TL. Healthcare waste management: A case study from the Cornwall NHS, UK 2015; 25(3):606-15.
- Ferreira AP, Veiga MM. Hospital waste operational procedures: A case study in Brazil 2013; 21(4):377-82.
- Da Silva CE, Hoppe AE, Mello N, Ravello MM. Medical waste management in the south of Brazil 2015;25(2):600-5.
- Federal Environmental Protection Agency (FEPA). Guidelines and standard for industrial effluents, gaseous emission and hazardous waste management in Nigeria 2001; 20-5.
- Oke IA. Management of immunization solid wastes in Kano state, Nigeria. Waste Management 2018; 28(3):2512-21.
- Kane A, Kane M, Lloyd J, Simonsen L, Zaffran M. Transmission of hepatitis B, hepatitis C and human immunodeficiency viruses through unsafe injections in the developing world: Model-based regional estimates. Bulletin of the WHO 2009; 77(5): 801-7.
- Chauhan R, Jha PK, Kumar M, Ramanathan A, Singh UK, Subramanian V. Assessment of the impact of landfill on ground water quality : a case study of Pirana site in western India. Environmental monitoring assessment 2018; 141(15): 309-21.
- Chukwuezie CI. Microbiology of refuse dumps in Port Harcourt. University of Port Harcourt, M.Sc. 2008;Thesis;49.
- Caviar B, Colwell RR, Deming JW, Peele ER, Singleton FL. Effects of pharmaceutical waste on microbial populations in surface waters at the Puerto Rico dumpsite in Atlantic Ocean. Applied Environmental Microbiology 2008; 41(3):873-9.
- Brisbe S, Ordinoha B. The management of Healthcare waste in tertiary healthcare institution in Port Harcourt, South –South Nigeria. Journal of Community Medicine and Primary HealthCare 2019; 21(5): 37-44.
- Karademir A. Health Risk Assessment of emissions from a hazardous and medical waste incinerator in Turkey. Environmental International Journal 2014; 30(4):1027-38.
- Cheeseman CR, Townend WK. Guidelines for the evaluation and assessment of the sustainable use of resources and of wastes management at healthcare facilities 2015; 23(7):398-408.
- National Bureau of Statistics Nigeria. State information, Nigeria. 2013
- John SA, Ocheke N, Odumosu P, Ndidi N. Waste management in healthcare establishments within Jos Metropolis, Nigeria. Africa Journal of Environmental Science Technology 2019; 3(12): 459-65.
- Griault E, Pruss A, Rushbrook P. Safe management of wastes from healthcare activities. Geneva, WHO 2009; 17-20.
- Kevin CD, Oguamanam OE. Knowledge, perception and practice of injection safety and hospital waste management among Teaching hospital staff in south east Nigeria. The Nigeria Health Journal 2015; 12(1):4-9.
- Coker AO. Medical waste management in Ibadan, Nigeria: Obstacles and Prospects. Waste Management Journal 2009; 29(2): 804-11.
- Ekugo EI. Public Health and Urban Sanitation. Environmental News 2008; 5(2):7-8.
- Farzadika M, Mohammadi MS, Moradi A. Hospital Waste Management status in Iran: A case study in the teaching hospitals of Iran. University of Medical Sciences 2009; 27(4):384-9.
- Islam MR, Uddin MN, Yesmin K. Knowledge on hospital waste management among senior staff nurses working in a selected medical college hospital of Bangladesh. Journal of Waste Management 2014; 20(14):57-69.
- Adogu P, Ubajaka CF. Knowledge and practice of medical waste management among health workers in a Nigerian General Hospital. Asian Journal of Science and Technology 2014; 5(12):833-8.
- Buregyega E, Musinguzi G, Musoke D, Ndejo R, Wang JS, Yu X. Occupational health hazards among healthcare workers in Kampala, Uganda. Journal of Environmental Public Health 2015;20(15):9-13.
- Abitebul D, Loft F. Health Professionals infected with HIV in France. France Medical Bulletin 2013; 5(20):111-3.
- Abah SO, Ohimain EI. Assessment of Dumpsite Rehabilitation Potential using the Integrated Risk Based Approach: A case study of Eneka, Nigeria. World Applied Science 2010; 8(4):436-42.
- Abegunde AA, Adegbita MA, Afon A, Bamise CT, Nwafor SO. Assessment of dental waste management in a Nigerian tertiary hospital. African Medical Journal 2010; 5(2):21-32.
- Abdullah MK, Al-mukhtar S. Assessment of medical waste management in teaching hospitals in Mosul City. A descriptive study. Mosul Nursing Journal 2013;1(1):1-18.
- Chitnis DS, Chitnis V, Vaidya K. Biomedical waste in laboratory medicine: Audit and management. Indian Journal of Medical Microbiology 2018; 23(5):6-13.
- Alagoz BA, Kocasoy G. Treatment and disposal alternatives for health-care wastes in developing countries – A case study in Istanbul, Turkey 2017;25(4)83-9.
- Adetunji B, Chima G, Gidado S, Isichei C, Ogoina D, Pondei K. Prevalence and determinants of occupational exposures to blood and blood fluids among health workers in two tertiary hospitals in Nigeria. African Journal of Infectious Diseases 2014; 8(2):50-4.
- Ramesh K, Ratan S. Knowledge, attitude and practice of health staff regarding infectious waste handling of tertiary care HCF at metropolitan city of Pakistan. Journal of Ayub Medical College Abbottabd 2013; 25(1-2): 45-122.
- Wahab AB. Waste Disposal and Environmental Hazard Control, Lagos. West African Health Examination Board 2001;22-34.